

Chinese American Oceanic and Atmospheric Association

COAA 2004



June 28-30, 2004
Beijing, China

An Overview of MODIS Radiometric Calibration and Characterization

XIAOXIONG XIONG

Earth Sciences Directorate, NASA/Goddard Space Flight Center, Greenbelt, MD 20771

WILLIAM BARNES

University of Maryland, Baltimore County, Baltimore, MD 21250

Abstract - The Moderate Resolution Imaging Spectroradiometer (MODIS) is one of the key instruments for the NASA's Earth Observing System (EOS), currently operating on both Terra and Aqua satellites. The MODIS is a major advance over its heritage sensors in terms of its spectral, spatial, and temporal resolutions. It has 36 spectral bands: 20 reflective solar bands (RSB) with center wavelengths from 0.41 to 2.1 μ m and 16 thermal emissive bands (TEB) with center wavelengths from 3.7 to 14.4 μ m, making observations at three spatial resolutions: 250m (bands 1-2), 500m (bands 3-7), and 1km (bands 8-36). MODIS is a cross-track scanning radiometer with a wide field-of-view, providing a complete global coverage of the Earth in less than 2 days. Both Terra and Aqua MODIS went through extensive pre-launch calibration and characterization at various levels. On-orbit, the calibration and characterization tasks are performed using its on-board calibrators (OBCs) that include a solar diffuser (SD) and a solar diffuser stability monitor (SDSM), a V-groove flat panel blackbody (BB), and a spectro-radiometric calibration assembly (SRCA). In this paper, we present an overview of MODIS calibration and characterization activities, methodologies, and lessons learned from pre-launch characterization and on-orbit operation. Key issues discussed in this paper include on-orbit efforts of monitoring detectors noise characteristics, tracking solar diffuser and optics degradation, and updating sensor's response versus scan-angle. The MODIS experiences and lessons learned have played and will continue to play major roles in the design and characterization of future sensors.

1. Introduction

The Earth Observing System (EOS) is the centerpiece of NASA's Earth Science Enterprise (ESE). Its overall goal is to enhance the scientific understanding of the Earth's land, oceans, and atmosphere, and the nature and human-induced effects on the global environment and climate changes. The Terra and Aqua spacecraft, launched in December 1999 and May 2002, respectively, are two of the major contributors to the EOS.

The Terra spacecraft carries five Earth observing instruments: (1) Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER), (2) Clouds and the Earth's Radiant Energy System (CERES), (3) Moderate Resolution Imaging Spectroradiometer (MODIS), (4) Multi-angle Imaging Spectro-Radiometer (MISR), and (5) Measurements of Pollution in The Troposphere (MOPITT). Carefully registered data products from simultaneous observations allow the EOS instrument teams to develop science approaches to better understanding specific problems. There are six instruments on Aqua: (1) Atmospheric Infrared Sounder (AIRS), (2) Advanced Microwave Scanning Radiometer for EOS (AMSR-E), (3) Advanced Microwave Sounding Unit (AMSU), (4) CERES, (5) Humidity Sounder for Brazil (HSB), and (6) MODIS. As a cornerstone instrument for the EOS, MODIS is operated on both Terra and Aqua¹⁻³.

The MODIS was designed and developed based on the desire of science community of collecting continuous global data for the studies of both short- and long-term changes in the Earth system. Its spectral bands and spatial resolutions were carefully selected in order to continue and enhance the observations of heritage

sensors, such as the National Oceanic and Atmospheric Administration (NOAA) Advanced Very High Resolution Radiometer (AVHRR), the Landsat Thematic Mapper, the Nimbus 7 Coastal Zone Color Scanner (CZCS), and NOAA's High Resolution Infrared Radiation Sounder (HIRS). MODIS has 36 spectral bands: 20 bands with wavelengths from 0.41 μ m to 2.2 μ m are the reflective solar bands (RSB) and the 16 bands with wavelengths from 3.5 μ m to 14.5 μ m are the thermal emissive bands (TEB). It has three nadir spatial resolutions: 250m for bands 1-2, 500m for bands 3-7, and 1km for bands 8-36. The equator crossing time of the Terra spacecraft orbit is 10:30 AM descending southwards and that of Aqua spacecraft is 1:30 PM ascending northwards. With complementing morning and afternoon observations, the Terra and Aqua MODIS have greatly enhanced the ability to monitor global environment and climate changes.

There are approximately 40 science data products generated from observations of each MODIS instrument. To ensure the quality of data products, both Terra and Aqua MODIS went through extensive pre-launch calibration and characterization, including various tests at component level, sub-system level, and thermal vacuum (TV) system-level. On-orbit, the instrument is calibrated and characterized using its on-board calibrators: a solar diffuser (SD) and a solar diffuser stability monitor (SDSM), a v-groove flat panel blackbody (BB), and a spectro-radiometric calibration assembly (SRCA)⁴⁻⁶.